METHODS OF SAMPLING AND TESTING

MT 216-10

METHOD OF SAMPLING AND TESTING CEMENT TREATED BASE
(Montana Test Method)

1 Scope:

1.1 This method covers the sampling and testing of the aggregate from the stockpiled material to establish the CTB mix design, and acceptance samples of the cement treated base aggregate and mixture during construction.

2 Referenced Documents:

2.1 MT Manual:
MT 201 Sampling Roadway Materials
MT 211 Moisture Density Relations of Soil-Cement Mixtures
MT 212 Determination of Moisture and Density of In-Place Materials
MT 601 Materials Sampling, Testing and Acceptance Guide

3 Apparatus:

3.1 Molds - The molds shall be solid-wall, metal cylinders manufactured with dimensions and capacities shown in 3.1.1. They shall have a detachable collar assembly approximately 2 3/4 in. (60 mm) in height, to permit preparation of compacted specimens of soil-cement mixtures of the desired weight and volume. The mold and collar assembly shall be so constructed that it can be fastened firmly to a detachable base plate made of the same material.

Note 1 - Alternate types of molds with capacities as stipulated herein may be used, provided the test results are correlated with those of the solid-wall mold on several soil types and the same moisture-density results are obtained. Records of such correlations shall be maintained and readily available for inspection when alternate types of molds are used.

3.1.1 A 4-inch mold having a capacity of 1/30 ± 0.0003 cu. ft. (944 ± 8.5 cm³) with an internal diameter of 4.000 ± 0.016 in. (101.6 ± 0.4 mm) and a height of 4.584 ± 0.005 in. (116.4 ± 0.1 mm).

3.1.2 Molds Out of Tolerance Due to Use - A mold that fails to meet manufacturing tolerances after continued service may remain in use provided those tolerances are not exceeded by more than 50 percent; and the volume of the mold, calibrated in accordance with Sec 6 (Calibration of Measure) of MT 203, Unit Weight of Aggregate, is used in the calculations:

3.2 Rammer:

3.2.1 Manually Operated - Metal rammer having a flat circular face of 2.000 ± 0.001 in. (50.8 ± 0.127 mm) diameter, a wear tolerance of 0.005 (0.127 mm) and weighing 5.50 ± 0.02 lb. (2.495 ± 0.009 kg) (Note 2). The rammer shall be equipped with a suitable guide-sleeve to control the height of drop to a free fall of 12.00 ± 0.06 (or 1/16 in.) (304.8 ± 1.524 mm) above the elevation of the soil. The guide-sleeve shall have at least 4 vent holes, no smaller than 3/8 in. (9.5 mm) diameter spaced approximately 90 deg. apart and approximately 3/4 in. (19 mm) from each end, and shall provide sufficient clearance so the free fall of the rammer shaft and head is unrestricted.

3.2.2 Mechanically Operated - A metal rammer which is equipped with a device to control the height of drop to a free fall of 12.00 ± 0.06 (or 1/16 in.) (304.8 ± 1.524 mm) above the elevation of the soil and uniformly distributes such drops to the soil surface. The rammer shall have a flat circular face 2.000 ± 0.001 in. (50.8 ± 0.127 mm) in diameter, a wear tolerance of 0.005 (0.127 mm) and a manufactured mass of 5.50 ± 0.02 lb. (2.495 ± 0.009 kg) (Note 2).
3 Apparatus: (continued)

**Note 2** - The rammer apparatus shall be calibrated with several soil-cement mixtures and the mass of the rammer adjusted, if necessary, to give the same moisture-density results as with the manually operated rammer. It may be impractical to adjust the mechanical apparatus so the free fall is 12 in. (305 mm) each time the rammer is dropped, as with the manually operated rammer. To make the adjustment of free fall, the portion of loose soil to receive the initial blow should be slightly compressed with the rammer to establish the point of impact from which the 12 in. (305 mm) drop is determined. Subsequent blows on the layer of soil-cement may all be applied by dropping the rammer from a height of 12 in. (305 mm) above the initial-setting elevation, or when the mechanical apparatus is designed with a height adjustment for each blow, all subsequent blows should have a rammer free fall of 12 in. (305 mm) measured from the elevation of the soil as compacted by the previous blow.

3.2.3 **Rammer Face** - The circular face rammer shall be used but a sector face rammer may be used as an alternative provided the report shall indicate type of face used other than the 2 in. (50.8 mm) circular face and it shall have an area equal to that of the circular face rammer.

3.3 **Sample Extruder** - A jack, lever, frame, or other device adopted for the purpose of extruding compacted specimens from the mold.

3.4 **Balances and Scales** - A balance or scale of at least 25 lb. capacity having a sensitivity and readability to 0.01 lb., or a balance or scale having a capacity of approximately 11.5 kg. and a sensitivity and readability to 5 grams. Also, a balance of at least 1 kg capacity with a sensitivity and readability to 0.1 gram.

3.5 **Drying Oven** - A thermostatically controlled drying oven capable of maintaining a temperature of 110 ± 5º C (230 ± 9º F) for drying moisture samples.

3.6 **Straightedge** - A hardened steel straightedge at least 10 in. (254 mm) in length. It shall have one beveled edge, and at least one longitudinal surface (used for final trimming) shall be plane within 0.01 in. per 10 in. (0.1 percent) of length within the portion used for trimming the soil (Note 3).

**Note 3** - The beveled edge may be used for final trimming if the edge is true within a tolerance of 0.01 in. per 10 in. (0.1 percent) of length; however, with continued use, the cutting edge may become excessively worn and not suitable for trimming the soil to the level of the mold. The straightedge should not be so flexible that trimming the soil surface with the cutting edge will cause concave soil surface.

3.7 **Sieves** - 50, 19.0, 4.75 mm sieves conforming to the requirements of MT 405, Sieves for Testing Purposes.

3.8 **Mixing Tools** - Miscellaneous tools such as mixing pan, spoon, trowel, spatula, etc., or a suitable mechanical device for thoroughly mixing the sample of soil with increments of water.

3.9 **Container** - A flat, round pan for moisture absorption by soil-cement mixtures about 12 in. (300 mm) in diameter and 2 in. (50 mm) deep.

3.10 **Moisture Containers** - Suitable containers made of material resistant to corrosion and not subject to change in weight or disintegration on repeated heating and cooling. Containers shall have close-fitting lids to prevent loss of moisture from samples before initial weighing and to prevent absorption of moisture from the atmosphere following drying and before final weighing. One container is needed for each moisture content determination.

3.11 **Butcher Knife** - A butcher knife approximately 10 in. (250 mm) in length, for trimming the top of the specimens.
4 CTB Mix Design:

4.1 **Stockpiled Aggregate** - Submit a 300 lb. (136 Kg) sample of the stockpiled aggregate from an approved source to the Materials Bureau for the CTB mix design. The procedure is as follows:

4.1.1 Sample the stockpile according to MT 201, paragraph 10 - (Stockpile Samples) and then submit to the Materials Bureau for the CTB mix design after sufficient quantity has been accumulated to insure a satisfactory average stockpile gradation. Also submit a sample of cement and fly ash to be used in the mixture.

4.1.2 Submit the contractor’s Job Mix Target and gradation test results for the stockpile along with the sample.

4.1.3 When the sample of aggregate, has been received in the Materials Bureau, it will be tested to determine the mix design as follows:

4.1.3.1 A moisture-density determination, cement content and fly ash content (if required) will be determined.

4.1.3.2 Using the optimum moisture and maximum density as determined in AASHTO T134, a 7-day and a 28-day compressive specimen and a freeze-thaw and wet-dry specimen will be molded for each of three cement contents (one cement content will be at the median, one at 1% less than median, and one at 1% more than median).

4.2 At the conclusion of the testing, a mix design will be established consisting of:

4.2.1 The optimum moisture content,

4.2.2 The maximum density,

4.2.3 The recommended cement content, (% of cement by wt. of dry aggregate),

4.2.4 The recommended fly ash content, (% of fly ash by wt. of dry aggregate),

4.2.5 Minimum 7-day compressive strength requirement.

5 Acceptance:

5.1 **In-Place Densities** - In-place densities will be determined in accordance with MT 212. A corrected moisture curve must be established by correcting the nuclear moisture reading to oven-dry moisture contents.

5.1.1 **Field-Made Compression Specimens** - A minimum of one set of specimens per two-lane mile per lift shall be molded in accordance with Section 5 and submitted to the Materials Bureau for testing. It is desirable that these specimens represent the material placed at the locations of the in-place densities in order that moisture-density comparisons can be made. One specimen will be tested as a 7-day compression specimen and the other as a 28-day compression specimen. The Materials Bureau will supply shipping boxes and blank forms to accompany samples. A copy of the form to accompany specimens will be placed in the plastic envelope in the shipping box and a copy mailed to the Materials Bureau.

5.1.2 **Acceptance Samples of Aggregate** - sample for gradation analysis in accordance with contract specifications. See MT 601 - “Aggregate, Cement Treated Base, When Used.”
6 Molding Specimens in the Field:

6.1.1 Sample the CTB mixture placed on the roadway. It must be transported to the place of molding as quickly as possible in order to minimize hydration. (Excessive hydration can reduce the lubrication properties and result in less than maximum density and therefore lower strengths.)

6.1.2 Form a specimen by immediately compacting the mixture in the mold, (with the collar attached) and later trimming the specimen in accordance with Section 7.2 in MT 211, and in addition:

6.1.3 Spade along the inside of the mold with a spatula as the mixture for each layer is placed in the mold and before compaction, to obtain uniform distribution of the material retained on the 4 Mesh (4.75 mm) sieve.

6.1.4 During compaction, obtain a representative sample of the mixture, weighing not less than 500 grams. Weigh the sample immediately and dry in an oven at 230 ° ±9°F (110 ° ±5°C) at least 12 hours or to constant mass to determine the moisture content as a check against design moisture content.

6.1.5 Weigh the compacted specimen to check against design density and permit to cure for 24 hours. (Note 3)

Note 3 - During the initial curing period, the specimen must be kept damp and maintained as nearly as possible at a temperature of 73.4 ° ±3°F (23 ° ±1.7°C).

6.1.6 Form a second specimen as rapidly as possible. One specimen will be identified as a 7-day compression specimen, the other a 28-day compression specimen. (Note 4).

Note 4 - A satisfactory method of identifying the specimens for the 7-days or 28-days, of curing in the moist room, is to wrap a piece of masking tape around the specimen. Indicate on the masking tape the date made, stationing & lane, type of test, etc. Allow sufficient space for the Materials Bureau to show the laboratory number and the breaking date.

6.1.7 Cure the compacted specimens in the molds overnight. Extract the specimens from the molds, place in the shipping box packed in damp sawdust, and transport to the Materials Bureau as soon as possible in order that final curing can be accomplished in the approved curing room.